REMARKS

Claims 1 - 8 have been amended hereinabove consistent with the Examiner's remarks where appropriate, and upon applicants' initiative in other portions. It is believed the standing objections and rejection under 35 USC 112 have now been overcome.

The standing rejection of claims 1-3 under 35 USC 103 in view of Odaira is respectfully traversed. Applicants do not agree that the reference, Odaira, discloses a process of manufacturing a wiring board, which obviates that of the present invention. Odaira suggests quite a different method, in which wiring patterns (copper plated layer 5) are formed on the surfaces of the Odaira upper and lower dies (1,2), by means of plating resist layers (4). Odaira uses an insulating resin (6) to fill the hollow space between his dies (1,2) so that the wiring patterns are integrated to form a wiring board.

To the contrary, in the present invention, a resin plate is first provided with wiring pattern recesses and via through holes; the surfaces of the resin plate including inner walls of the wiring pattern recess and the via through holds are coated with a metal film; a plated metal is formed by electo-plating and then polishing the plated metal; and then the metal film is polished, so that the wiring pattern and vias are exposed.

Odaira suggests nothing about these significant features in the present invention. Moreover, Neither Tokuda nor Koyama teaches or suggests these features. The 35 USC 103(a) rejection of claims 1-3 should be withdrawn.

Similarly the 35 USC 103(a) rejection of claims 4, 5 and 6-8, which also rely upon a similar alleged teaching in Odaira, should be withdrawn.

New claims 9 - 14 avoid the prior art. Further examination of the application as to the amended claims 1 - 8 and new claims 9 - 14 is requested. It is urged that the case be passed to issue with these claims.

Respectfully submitted,
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Figures 10(a) to 10(e) are views explaining a process for manufacturing a wiring board process conventionally known in the prior art.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Fig. 1(a) to 1(e) explain an embodiment of a process for manufacturing a wiring board process according to this invention, in which the wiring board is produced by a press-forming a processing resin plate. First, the processing resin plate 10 as shown in Fig. 1 (a) is subjected to press forming by a pair of molds l4a and l4b as shown in Fig. 1 (b) so that a resin plate 12 is obtained. The resin plate 12 is formed with the wiring pattern recesses 16, ~~16, ..~~ and the via through holes 18~~, 18, .. by~~ the pair of molds 14a and 14b.

Either of a thermoplastic resin or a thermosetting resin can be used as the processing resin plate 10. In case of using a thermoplastic resin, it is preferable that the processing resin plate 10 is softened by heating so that a press forming can be smoothly carried out. In case of using a thermosetting resin, it is preferable to use such a processing resin plate which is softened so as to smoothly carrying out the press forming process.

A thin metal film 20 is formed all over the surface including the inner walls of the via through holes 18, ~~18, ..~~ and the wiring pattern recesses 16 ~~, 16, ..~~ . Although the metal film 20 can be formed by vapor deposition or sputtering, it is preferable to form such a thin metal film 20, made of such as a copper, by electroless-plating.

Next, as shown in Fig. 1 (d), an ~~An~~ electro-plating is applied to the resin plate 12 covered with the thin metal plate 20 using the thin metal plate 20 as a power supply layer, so that the via through holes 18, ~~18, ..~~ and the wiring pattern recesses 16~~, 16, ..~~ are filled with the plated metal to form a metal layer 22. The metal layer 22 is also formed on the surface of the resin plate 10 where the via through holes 18 and the wiring pattern recesses 16 are not formed. The metal

layer 22 serves to electrically connect the vias and the wiring patterns which are formed by filling the via through holes 18 and the wiring pattern recesses 16 with the plated metal.

Therefore, the metal layer 22 formed on the resin plate 12, except for the portions of the metal layer 22 formed on the inner walls of the via through holes 18 and the wiring pattern recesses 16, is partially polished to obtain a wiring board 30 in which the surfaces of the vias 18 ~~22, 22, ...~~ and the wiring patterns 24 ~~, 24, ..~~ are exposed at the same level as the surface of the resin plate 12, as shown in Fig. 1(e).

As shown in Fig. 1(e), the wiring board 30 is formed by polishing the respective surfaces of the resin plate 12 and thus a semiconductor package, as shown in Fig. 2, on which a semiconductor element 36 can be mounted, can thus be obtained. The semiconductor package shown in Fig. 2 is provided on one of the surfaces of the resin plate 12 with solder balls 34 ~~, 34, ...~~ as connecting terminals which can be connected to electrode terminals of the semiconductor element 36 to be mounted, and on the pads formed on the other surface of the resin plate 12 with solder balls 32 ~~, 32, ..~~ as external connecting terminals.

The respective surfaces of the resin plate 12 are coated with solder resists 38~~, 38~~ except for the solder balls attached to the respective pads.

The wiring board 30 shown in Fig. 1(e) can be used as a core substrate and therefore multi-layer wiring patterns are formed on the respective surfaces of the core substrate to obtain a multi-layer wiring board.

The wiring board 30 in this embodiment can be made by filling the plated metal into via through holes 18 and wiring pattern recesses 16, made by press forming the resin plate 12, to form the vias 26 and wiring patterns 24. Therefore, the via through holes 18 and wiring pattern recesses 16 can be made simultaneously as compared with drilling and thus a multi-layer wiring

board, in which a plurality of the vias 26 are very densely arranged, can be obtained with low cost.

A conventionally known build-up method shown in Fig. 3(a) to 3(d) can also be used to make a multi-layer wiring board using the wiring board 30 as a core substrate. Fig. 3(a) to 3(d) explain a process for forming wiring patterns on one of the surfaces of the wiring board 30. However, it is also possible to simultaneously form such wiring patterns on the other surface of the wiring board 30, although an explanation is omitted.

In this build-up method, after resin layers 40 are formed on the respective surfaces of the wiring board 30 as a core substrate as shown in Fig. 3(a), via recesses 42 are formed by irradiating laser light, such as CO_2 laser or excimer laser light, to the positions of the resin plate 40 to form via recesses 42, as shown in Fig. 3(b). Pad surfaces are exposed on the bottom of the via recesses 42.

Next, as shown in Fig. 3(c), a metal layer 44 having a certain thickness is formed by electro-plating over all of the surfaces of the resin plate 40 including the inner walls of the via recesses 42 using a thin metal film formed by electroless-plating as a power-supply electrode. It is preferable that this metal layer 44 is made of copper.

Then, the metal layer 44 is patterned to form wiring patterns 46 and vias 48, as shown in Fig. 3(d).

Next, a resin layer 40 is also formed on the resin layer 40 provided with the wiring patterns 46 and vias 48, and the steps of Figs. 3(b) to 3(d) are repeated to obtain a multi-layer wiring board as shown in Fig. 4.

The multi-layer wiring board 40 shown in Fig. 4 is also a semiconductor package, on which a semiconductor element 36 can be mounted, wherein the semiconductor package is provided on one of the surfaces of the resin plate 12 with solder balls 34 ~~, 34, . .~~ as connecting

terminals which can be connected to electrode terminals of the semiconductor element 36 to be mounted, and on the pads formed on the other surface of the resin plate 12 with solder balls 32 ~~, 32, ..~~ as external connecting terminals.

The respective surfaces of the multi-layer wiring board are coated with solder resists 38 ~~, 38~~ except for the solder balls 32 attached to the respective pads.

In the multi-layer wiring board ~~40~~ 30 shown in Fig. 4, as the resin layer 40 is again formed on the resin layer 40 formed with the wiring patterns 46 and vias 48 to form wiring patterns 46 and the vias 48, the upper layer of the resin layer 40 for forming the multi-layer wiring board can be easily an uneven surface.

In this connection, as shown in Figs. 5(a) to 5(e), a multi-layer wiring board 40 is formed by press-forming, the surface of the upper, resin layer 40 of the multi layer wiring board can be made flat. Fig. 5(a) to 5(e) also explain a process for forming wiring patters on one of the surfaces of the wiring board 30. However, it is also possible to simultaneously form such wiring patters on the other surface of the wiring board 30, although an explanation is omitted.

In this embodiment, after resin layers 40 are formed on the respective surfaces of the wiring board 30 as shown in Fig. 5(a), via recesses 42 ~~, 42, ...~~ and wiring pattern recesses 16 ~~, 16, ..~~ are formed by press-forming using a pair of pressing molds 50 ~~, 50~~ (in Figs. 5(a) and 5(b), one of the pressing molds 50 ~~, 50~~ is only shown). There is a possibility that a resin film remain on the bottom of the via recesses 42. Therefore, the resin film remained on the bottom of the via recesses 42 is removed by etching so that the pads are completely exposed on the bottom of the via recesses 42.

Next, as shown in Fig. 5(c), a thin metal film 52 is formed over the all surfaces of the resin layer 40 including the inner walls of the via recesses 42 and

wiring pattern recesses 16 by such as electroless-plating.

In addition, an electro-plating is carried out using the metal film 52 as a power-supply layer, as shown in Fig. 5(d), to fill the plated metal into the via recesses 42 and wiring pattern recesses 16 to form a metal layer 54 having a certain thickness. It is preferable that this metal layer 54 is made of copper.

The metal film 52 is also formed on the surface of the resin layer 40 where the via recesses 42 or wiring pattern recesses 16 are not formed. The surfaces of the metal layer 54 corresponding to the via recesses 42 or wiring pattern recesses 16 may be uneven, so that vias and wiring patterns which have been formed by filling plated metal into via recesses 42 or wiring pattern recesses 16 electrically short-circuit to each other.

Therefore, the metal layer 52 attached to the resin layer 40 is polished except for the inner walls of the via recesses 42, ~~42, ..~~ and the wiring pattern recesses 16, ~~16, ...,~~ so that the surfaces of the vias 56~~, 56, ..~~ and the wiring patterns 24 ~~, 24, ..~~ are exposed at the same level as the surface of the resin layer 40.

Although, in the wiring board 30 of the previous embodiments shown in Figs. 1(a) to 5(e), the resin plate 12 in which the wiring pattern recesses 16 ~~, 16, ..~~ and via though holes 18 ~~, 18, ..~~ are formed by press-forming is used, such a resin plate 12 can also be made by injection molding.

Figs. 6(a) and 6(b) show a method of making a resin plate 12 by injection molding. In this injection molding, a pair of molds 60a and 60b having projections for forming wiring pattern recesses 16 and projections 62 for forming via through holes 18 is used. The pair of molds 60a and 60b can be made by a known electric-forging method.

Next, as shown in Fig. 6(b), after the pair of molds 60a and 60b are closed, a resin 66 is injected into the

cavity defined in the pair of molds 60a and 60b. The resin may either be thermoplastic resin or thermosetting resin which have fluidity to easily flow through the narrow gaps defined by the projections 62 and 64 in the cavity.

However, if the resin 66 is a thermosetting resin, it is necessary to harden the resin after it is filled in the cavity by heating the same. Also, if the resin 66 is a thermoplastic resin, it is necessary to solidify the resin after it is filled in the cavity by cooling the same.

After the resin 66 in the cavity is hardened or solidified, the pair of molds 60a and 60b are opened and thus a resin plate as shown in Fig. 1(b) can be obtained.

Thereafter, a wiring board 30 can be obtained using a resin plate 12 by the steps as shown in Figs. 1(a) to 1(e).

As shown in Figs. 7(a) and 7(b), a multi-layer wiring board can be obtained by using such an injection molding. Fig. 7(a) and 7(b) explain a process for forming wiring patterns on one of the surfaces of the wiring board 30. However, it is also possible to simultaneously form such wiring patterns on the other surface of the wiring board 30, although an explanation is omitted.

First, as shown in Fig. 7(a), a pair of molds 68, 68 (in Figs. 7(a) and 7(b) only one of the pair of molds 68, 68 is shown) having projections 72 for forming wiring pattern recesses 16 and projections 70 for forming via recesses 42 is used. This pair of molds 60a and 60b can be made by a known electric-forging method.

Next, the pair of molds 68, 68 are closed to define a cavity 74 into which a wiring board 30 is inserted, so that the tip ends of the projections 72 for forming wiring pattern recesses 16 are come into contact with the pads of the wiring board 30.

Next, a resin 66 is injected into the cavity and solidified so as to form via recesses 42 ~~, 42, ..~~ (not shown) and

wiring pattern recesses 16 ~~, 16, ..~~ (not shown), on the resin layers 40 (not shown) provided on the respective surfaces of the wiring board 30.

In addition, by the same steps as Figs. 5(c) to 5(e), vias 56 ~~, 56, ..~~ and wiring patterns 16 ~~, 16, ..~~ can be formed.

Next, the wiring board 30 having the resin layer 40 provided with the vias 56 ~~, 56, ..~~ and wiring patterns 24 ~~, 24, ..~~ is inserted into the cavity 74 of the pair of injection molds 68, 68. The steps of injecting a resin 66 into the cavity 74 and hardening or solidifying the resin, and the steps of Figs. 5(a) to 5(e) are repeated to form a multi-layer wiring board.

The wiring board 30 shown in Fig. 2 has solder balls 32 ~~, 32, ..~~ as external connecting terminals on the other surface thereof. Therefore, during the manufacturing process of the wiring board 30 a step for attaching the solder balls 32 ~~, 32, ..~~ is necessary.

In this connection, since the wiring board 30 manufactured by the process of Figs. 8(a) to 8(c) is provided beforehand with projected portions for the external connecting terminals, so that a step for attaching solder balls 32 ~~, 32, ..~~ is no longer necessary.

First, as shown in Fig. 8(a), each of the pair of injection molds 80a and 80b is provided with projections 82 for forming wiring pattern recesses 16 and projections 84 for forming via through holes 18. In addition, the injection mold 80b is provided with recesses 86 ~~, 86, . . .~~ for forming projections for the external connecting terminals.

A processing resin plate 10 as shown in Fig. 1(a) is inserted into the space between these pair of injection molds 80a and 80b, which is then closed to form a resin plate 12 which is provided with the wiring pattern recesses 16 and the via through holes 18, and also provided with projections 88 for the external connecting terminals at the positions where the external connecting

terminals should be formed.

In addition, electro-plating is applied to all of the surfaces of the resin plate 12 including the inner walls of the wiring pattern recesses 16 and the via through holes 18 and outer wall of the projections 88 for the external connecting terminals using the thin metal film as a power supply layer. Thus, as shown in Fig. 8(b), the inner walls of the wiring pattern recesses 16 and the via through holes 18 are filled with a plated metal to form a metal layer 22. This metal layer is also formed on the surfaces of the resin plate 12 where the wiring pattern recesses 16 and the via through holes 18 are not formed.

Therefore, as shown in Fig. 8(c), the portions of the metal layer 22 attached to outer wall of the projections 88 for the external connecting terminals are removed and electrically disconnected from the vias 26 which are formed by filling the plated metal into the via through holes 18. Thus, a wiring board 30 is formed which has one surface on which vias 26 and the wiring patterns 24 are exposed, opposite to the other surface provided with projections 88 for external connecting terminals. Such a removal of the metal layer 22 can be carried out by polishing the metal layer on one of the surface of the resin plate 12. It is preferable to remove by etching the metal layer on the opposite surface of the resin plate 12 after forming resist patterns, exposure thereof and development thereof.

The wiring board 30 as shown in Fig. 8(c) has the other surface provided with the external connecting terminals 90 covered with metal layers 22 on the outer wall of the projections 88. The external connecting terminals 90 are electrically connected with the vias 26 by means of the wiring patterns 92.

Therefore, when the wiring board 30 shown in Fig. 8(c) is used as a semiconductor package, solder balls 34 ~~, 34, ...~~ as connecting terminals are attached to the pads

of the wiring patterns 24 formed on the one surface of the resin plate which are connected to the electrode terminals of the semiconductor element 36 which is to be mounted.

Solder resist 38 is attached to the respective surfaces of the resin plate 12 except for the portions corresponding to the solder balls 34 ~~, 34, ...~~ attached to the respective pads and the external connecting terminals ~~90, 90, ...~~ .

Although the pair of molds 80a and 80b are used to obtain a resin plate 12 having a predetermined shape in the embodiment shown in Figs. 8(a) to 8(c), the pair of molds 80a and 80b can be replaced with a pair of injection molds 80a and 80b between which a cavity is defined. When these injection molds 80a and 80b are closed, a molten resin is injected into the cavity to obtain a resin plate as shown in Fig. 8(b).

In the same steps as shown in Fig. 8(b), the inner walls of the wiring pattern recesses 16 and the via through holes 18 are filled with a plated metal to form a metal layer 22.

Then, in the same steps as shown in Fig. 8(c), the portions of the metal layer 22 attached to outer wall of the projections 88 for the external connecting terminals are removed and electrically disconnected from the vias 26 which are formed by filling the plated metal into the via through holes 18. Thus, a wiring board 30 which has one surface on which vias 26 and the wiring patterns 24 are exposed, opposite to the other surface provided with projections 88 for external connecting terminals can thus be obtained.

It should be understood by those skilled in the art that the foregoing description relates to only some preferred embodiments of the disclosed invention, and that various changes and modifications may be made to the invention without departing the sprit and scope thereof.